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Physiological Mechanisms of the Action of Aeroions

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The beneficial medical effect of negative light gas and heavy water atmospheric ions (aeroions, or airborne ions) upon certain diseases may be regarded as proved. To these diseases we attribute bronchial asthma, osena, primary stages of hypertension, flesh wounds, burns and scalds, ulcers. There are also some data in our home literature, as well as in the literature abroad, about the beneficial effect of negative aeroions upon bronchopneumonia, pulmonary t.b.c., coronar deficiencies, aphthous stomatitis, allergic diseases, neurodermitis, after effects of rheumatism and of grippe, etc.

The practical successes of aëroionic therapy make it indispensable to solve on experiments the question about the physiological mechanisms through which unipolar ionization acts upon the sound and sick organism.

Investigation^s of long duration (dating from 1932), carried out by the author of this article and his co-workers, as well as by other Russian and foreign^s physiologists, are encouraging for the solution of this problem.

The first step had been done by Sokoloff (1), the pioneer of aëroionic therapy. In his opinion aeroions, contrarily to all other physiotherapeutical agents, are acting upon the organism through the lungs in the process of respiration.

Sokoloff's surmise has been confirmed at our laboratory by the experiments of Kunevitsch (2) who investigated the effect of aeroions on the excitability (rheobase and chronaxie) of the m.gastrocnemius of rabbits. In these experiments a

radioactive aeroion generator of Verigo's system (3) had been placed, in the routine way, before the muzzle of the rabbit, so as to cause the animal to inhale ionized air. Every time one could observe well pronounced deviations of the motor chronaxie. In the control experiments the ionizer had been placed behind the animal in such ^a way, that the stream of aeroions was directed onto the skin of the hind legs of the animal deprived of the hair. At the same time a grounded metallic net had been put on the rabbit's head screening the respiratory system of the animal ^{from} ~~of~~ the aeroions. Under these conditions the aeroions exercised no practical influence, the motor chronaxie remaining without any changes.

Seemingly aeroions do not penetrate through the keratic layer of cutaneous epithelium into blood capillaries and are unable to irritate the skin receptors. In treating flesh wounds, persisting ulcers and stump wounds physicians sometimes successfully practice a local application of streams of negative aeroions directed upon the injured surface. However, the positive results of the local action of aeroions in such cases remain but doubtful, the patient being simultaneously exposed to a general ionization through his lungs. Aeroions exert influence on the integral organism, under conditions of preserved respiration, bloodcirculation and central nervous regulation. A stream of unipolar aeroions, either negative and positive, in our experiments, did not exert a well-marked and doubtless influence on isolated surviving organs (neuro-muscular preparations, heart of a frog) (Vasiliev and Bratschikova (4)). However, according to Krueger

and Smith (5) it exerts ^{the} influence on ciliary activity of isolated rabbit trachea.

Having penetrated into the respiratory tract and pulmonary alveoles, aeroions may act upon the organism in two ways: 1. reflexly, irritating the pulmonary interreceptors, 2. humorally-penetrating into blood through the cellular layer of alveolar epithelium. The experimental data obtained by our laboratory state the existence and co-action of these two physiological mechanisms (Vasiliev, 6).

The exclusion of one of these mechanisms (reflex or humoral) does not annihilate the effect of aeroions upon the organism though reduces it.

So, the experiments of Kunevitsch (7) showed that a bilateral cross-section of the pulmonary branches of n. vagi of a rabbit brought to a marked reduction of the influence of aeroions on the rheobase and chronaxi^{is} of the muscles of the hind legs but did not annihilate it. Vagotomy excludes the reflex mechanism of aeroion action leaving the humoral mechanism active. The reduction of the action of aeroions seemingly depends here on the exclusion of the reflex influence issuing from the pulmonary interoreceptors.

In order to reveal the rôle of the reflex mechanism in the action of aeroions Blagodatova (8) excluded the humoral mechanism eliminating blood supply to one of the hind legs of the rabbit, this being achieved by section^{ing} the exterior iliae artery with a further clamping of the latter. ^{tension} Strength-duration curve^(according to Lapicque) had been used as the index of changes taking place in the excitability of the muscles of the leg. It has been proved that negative aeroions produced by the

Verigo radioactive ionizer exert influence on the excitability of the neuro-muscular apparatus either before and after the elimination of blood-supply. In both cases the excitability of the muscle increased. The absence of blood-supply to the muscle did not annihilate the influence of the inhaled aeroions on its excitability. This fact confirms once more the important rôle of the reflex mechanism in the action of aeroions.

The existence of the humoral mechanism of the action of aeroions had been first revealed under clinical conditions during world war 2 while applying aeroion therapy to various forms of wounds of the peripheral or central nervous systems. Observations had been carried out on 14 wounded with a sectional resection of n. radialis or n. medianus with a further application of an epineural suture. The muscles corresponding to the operated nerves (common extensor or common flexor of the fingers) were fully disconnected from the central nervous system. The functional indexes of these denervated muscles displayed deviations towards an increase, the rheobase giving only a slight, the chronaxie - a multiple increase, the constant of accommodation (according to Hill) being by 3-4-times greater as compared to the value of the same indexes measured on the sound arm. In this case the pathologically increased constant of accommodation (λ) appeared to be the sensitive reagent to the influence of negative aeroions (they amounted to 100.000 per 1 cm³ of air). After each séance of aeroionization therapy the constant ^{the time of} temporarily diminished, by 27 msec. on an average, this corresponding to 34% of the control value measured on the sound arm. This fact proves, that the introduction of negative aeroions into the lungs exerts a temporary normalizing effect on the functional state of the ske-

leton muscles disconnected from the central nervous system. (Vasiliev and Latmanizova, 9).

Analogous data have been obtained by Berezina (10) on 4 wounded patients with a syndrom of complete transversal rupture of the thoratic (3 cases) or lumbar (1 case) segments. In these cases the connection between the neuromuscular apparatus of the upper extremities and the central apparatus of the cerebrum remained normal, whereas the lower region of the spinal cord and the lower extremities, due to the rupture of the spinal cord, were deprived of any connection through the nerves, this connection could be realized only through the humoral mechanism by means of blood.

Observations, however, showed that a single séance of inhalation of negative aeroions (concentration of about 100.000 ions per 1 cm³ of air) in all cases led to a diminution ~~nishing~~ of motor chronaxie not only in the upper, but also in the lower extremities disconnected from the cerebrum, this gaining stability with the number of séances.

Clinical observations, however, do not display the same convincing power which is characteristic of experiments on animals performed under laboratory conditions. A direct proof of the humoral mechanism of the action of aeroions could be obtained only by means of experiments on warm-blooded animals performed under conditions of cross-bloodcirculation. Such kind of experiments had been performed at our laboratory by Skorobogatova (11) on cats and rabbits. Blood coagulation had been prevented by means of preliminary injection of heparin. One of the two animals connected by cross-bloodcirculation (the donor) was inhaling, during 30 min., negative aeroions

generated by a radioactive ionizer in the quantity of 2.5 mln. per 1 cm³ of air. The other animal (the recipient) was kept under conditions excepting any possibility of inhaling aeroions. In the course of the experiment either the blood-pressure of both animals was being graphically recorded or the excitability of one of the muscles of the hind leg was being measured by means of a chronaximeter.

In the majority of these experiments inhalation of negative aeroions was provoking in the donor-animal a twophase deviation of blood-pressure, - at first it rose for a short time then, to the end of the experiment, it fell by 10-15 mm Hg lower than the initial level. Eight or ten minutes later the same but slighter changes in blood-pressure took place in the recipient-animal. In all the experiments the arterial pressure reached its initial level ⁱⁿ 1-2 hours after the end of the séance of ionization, the recipient recovering the normal pressure somewhat sooner than the donor. In the control experiments (the donor-cat did not inhale aeroions) the level of blood-pressure of both animals in the course of two hours did not display any significant changes.

Analogous results have been also obtained by A.M. Scorobogatova during chronoxymetrical experiments. Inhalation of negative aeroions called forth in the donor-animal a diminution of the muscular chronaxia after ten minutes, the same phenomenon being observed in the recipient-animal again by 10-12 minutes later.

The transmission of the influence of aeroions from the donor to the recipient under conditions of cross-blood-circulation stated by our experiments could be realized only through

blood, i.e. via humoralis, in this case, without the participation of the nervous system. The blood of the donor, altered ⁱⁿ as result of the inhalation of aeroions, acquires the capacity of calling forth in the recipient the same functional changes which in the donor are provoked by the aeroions. This result obtained from laboratory experiments on animals are in concordance with the clinical observations of Grobstein and Kersanov (12) carried out in the course of the treatment of patients suffering from osena by means of negative aeroions. Grobstein and Kersanov have proved that a direct transfusion of the blood of a donor daily subjected to a séance of negative aeroionization to a patient suffering from osena exerts upon the latter almost the same beneficial effect as in case of a direct inhalation of negative aeroions by the patient himself. In both cases one can observe a well marked reduction of the osenal syndrom.

The above experimental data are a sufficient proof of the existence of two physiological mechanisms of the aeroion action, i.e. of the reflex mechanism originating from the pulmonary interoreceptors and of the "elect^uhumoral" mechanism manifesting itself in the influence of the blood altered by the inhalation of aeroions on the organs and tissues. The first to act is the reflex mechanism, the second to act is the humoral one.

There are found in literature some indications on the existence of still another reflex mechanism of the action of aeroions. According to Faibushevitch (13) the blood, the electrochemical properties of which had altered under the influence of aeroions, is able to irritate the interoceptors

of blood vessels in particular those of the carotid synus and of the arch of the aorta, and through these, by means of centripetal fibres of the nerves, it acts on the vasomotor and other centres of the medulla.

In order to verify this surmise on experiments Lebedinskaya (14) applied at our laboratory the method of a temporary exclusion of the vasoreceptors by injecting into the aural vein of a rabbit a 1% solution of novocain, with a further ionization. The dose of novocain amounted to 15-30 mg per 1 kg of the weight of the animal and had been introduced at a velocity of 1 cm³ of the solution during 20-40 sec. As a rule this dosage provoked a state of sleep inhibition in the rabbit. The deviations of the subordinate chronaxie and rheobase of the m. gastrocnemii served as an index of the changes of the functional state of the central nervous system. A Verigo radioactive ionizer generating about 1 mln. of negative aeroions per 1 cm³ of air was used in these experiments.

Before the injection of novocain the inhalation of negative aeroions diminished the chronaxie by 16.7% on an average, whereas the inhalation of positive aeroions increased it by 18.3% on average. After the injection of novocain, when the sleep inhibition had manifested itself, the influence of aeroions on the chronaxie instead of disappearing, increased even more in some of the experiments; the negative ions proceeded to diminish, and the positive aeroions to increase the chronaxie. The deviations of the rheobase, provoked by the influence of aeroions either before and after the administration of novocain, were also on a whole of the same nature, - the negative ions increasing and the positive ions diminishing the rheobase.

These simple and plain results were, however, complicated by the fact that the injected novocain by itself brought to an abrupt change of the excitability of muscles, the chronaxie increasing by 30.6%, the rheobase increasing by 18.5% on an average. Against this altered functional back-ground the aeroions still continue to exert the above mentioned polar influence on the index^e of the muscular excitability. This fact proved^e, that the reflexes originating from interoceptors of blood-vessels do not play a significant rôle in the action of ~~the~~ aeroions on the organism.

The influence of the light negative aeroions as, apparently, also of the heavy negative water ions on a sound and sick organism if used in therapeutical dosage (100-150 mln. ions in the course of a séance according to Bulatov) is characterized by a number of peculiar features.

They normalize the pathologically altered functional indexes of different kinds, e.g, they retard RSE, reduce blood-pressure in those cases when these indexes are pathologically high and raise them when they are pathologically low (Bulatov, 15; Moreva, 16, and others).

Aeroions exert a well-marked desensibilizing effect milding the course of an anaphilactic shock in rabbits and displaying a beneficial influence on the course of allergic diseases (P.K. Bulatov, 1951; Z.E. Moreva, 1956). This result has been recently confirmed by Roumanian investigators (prof. Cupcea and co-workers, 17).

Increasing the functional mobility (lability according to prof. N.E. Vvedencky) and reducing the excitability of the central nervous system, negative aeroions exert a "deparabio-

tizing" action on central and peripheral formations subordinated to the cerebrum, thus eliminating the foci of pathological dominants and of the pathological parabiosis. So, for instance, a systematical exposition of rabbits to negative ionisation (in a series of séances) accelerates by 30% on an average the restoration of the normal functional state of the anaemized (by means of a section of the exterior iliac artery) neuromuscular apparatus of the hind leg as compared to those animals who had not been subjected to a "course of treatment by ionization" (Blagodotowa, 8).

A number of investigations⁰²¹ point out to the soporific action of the negative aerions. According to some symptoms they strengthen the preservative inhibition in the cortex of the large hemispheres of the cerebrum. This function, according to acad. I.P. Pavlov's teaching, is of great importance for the a favourable course of various diseases among them of infectious nature. In this respect our experiments on rabbits are quite significative. We exposed rabbits to the influence of diphtheric toxin which provoked in them the symptoms of myocarditis (Gadzala, 18). The toxin had been injected into the vein in the quantity of 0,4 ml, in the proportion of 1:100. The experiments revealed that if a rabbit had been daily subjected to negative ionization of half an hour duration (concentration 1,5 mln ions per 1 cm³ of air), the development of myocarditis provoked by the diphtheritic toxin slowed down, the reaction of the organism to the diphtheritic intoxication being weaker, as well, as the destructive processes in the myocardis. This fact had been stated with the help of the electrocardiographic method. Due to the beneficial action of

the negative ionization, the rabbits survived 16-20 days on an average whereas the control group of rabbits who had not been subjected to any ionization perished on the 6-8th day, the first to perish were the rabbits who had got positive ionization, - they perished in the course of 2-5-days.

The above experimental findings show that the influence of atmospheric ions on a sound and sick organism is a biophysical problem of great importance requiring a thorough investigation; it opens a new practical branch of physical therapy.

Summary

1. Contrarily to all other physical agents of the external medium, aeroions act on the organisms of men and warm-blooded animals through the lungs in the process of respiration. As to animals with a well developed cutaneous respiration (e.g. frogs), the influence of aeroions may be realized through the cutis as well.

2. Having penetrated into the respiratory tract and alveoles, aeroions exert hence their influence on the organism and its organs in two ways: reflexly, - irritating the pulmonary interoreceptors and humorally, - penetrating into blood through the cellular layer of alveolar epithelium.

3. The existence of the reflex mechanism has been proved by the fact of a well pronounced decrease of the effect of aeroions on the functional state of the organs (in particular on the excitability of skeleton muscles) after the exclusion of reflex influence issuing from the pulmonary interoreceptors, this being done by means of bilateral cross section of the pulmonary branches of n. vagi.

4. The existence of the reflex mechanism of the action of aeroions has been also confirmed by the preservation of their influence on the excitability of skeleton muscles after the exclusion of blood-circulation in them by means of section^{ing} the corresponding vessels.

5. The existence of the humoral mechanism of the action of aeroions has been proved by the mere fact of a partial preservation of the influence of ions on the excitability of muscles after a bilateral section of the pulmonary branches of n. vagi. A most significative proof has been gained from the experiments with cross-blood-circulation between two warmblooded animals (rabbits or cats). These experiments showed that the functional deviations (in the excitability of muscles and in blood-pressure) provoked in the donor by the inhalation of aeroions appear also in the perceptive fully protected from the possibility of inhaling aeroions.

6. The existence of a supposed humoral-reflex mechanism of the action of aeroions realized from the receptors of blood vessels could not be proved by experiments in which these receptors had been excluded by injecting novocain. After the exclusion of the vasoreceptors the influence of aeroions on the excitability of the skeleton muscles does not change.